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Testing Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting

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Testing Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting

K 7125-1987
(Reaffirmed: 1994)

1. Scope

This Japanese Industrial Standard specifies the method to measure the coefficients of friction by letting the test piece slide on the other facing material in order to measure the static coefficient of friction and the kinetic coefficient of friction, hereinafter referred to as the "coefficient of friction", due to the sliding friction of plastic film and sheeting (1). Provided that this standard does not apply, as a rule, to the those with an indication of static electricity or heat, the materials causing the friction distinctly and the those of which the test piece in the natural condition or under contacting force is adhesive.

Note (1) The test piece used herein is not more than 0.2 mm in thickness, as a rule. Provided that as far as the test is free from hindrance, even the test piece of more than 0.2 mm may be subjected to the agreement between the parties concerned.

Remarks 1. Where the coefficients of friction of plastic materials are compared, the sliding piece, the other facing material, measuring method, etc. shall be taken in consideration.

2. The units and numerical values given in { } in this Standard are in accordance with the conventional system of units and are appended for informative reference.

Applicable Standards:

JIS B 0601-Definitions and Designation of Surface Roughness

JIS B 7503-Dial Gauges Reading in 0.01 mm

JIS B 7507-Vernier Callipers

JIS B 7509-Dial Gauges Reading in 0.001 mm

JIS B 7601-Trip Balances

JIS K 6900-Glossary of Terms Used in Plastic Industry

JIS K 7100-Standard Atmospheres for Conditioning and Testing of Plastics

JIS L 3201-Wool Press Felts

JIS Z 8401-Rules for Rounding off of Numerical Values

Corresponding International Standard:

ISO 8295 -Plastics-Film and sheeting-Determination of the coefficients of friction

2. Definitions

For the purposes of this standard, the following definitions apply. Other definitions are given in JIS K 6900.

(1) friction force Static friction force when the contact surface causes slip movement and kinetic friction force during movement.

(2) contact force Force acting vertically on the contact surface between the measured materials.

(3) coefficient of friction Ratio of frictional force to contact force.

(4) sled Weight to give the contact force.

(5) other facing material Material to be rubbed against the test piece and be attached to the test table.

3. Conditioning of Test Piece and Testing Temperature and Humidity

3.1 Conditioning of Test Piece The conditioning of test piece shall, as a rule, be carried out for not less than 88 h (²) under the standard temperature condition Grade 2 and the standard humidity condition Grade 2 (temperature 23 ± 2°C and relative humidity 50 ± 5 %) of JIS K 7100 prior to the test.

Note (²) If it can be confirmed that the conditioning of not less than 88 h and that of not more than 88 h are not changed in test results, the conditioning time may be shortened.

3.2 Test Temperature and Humidity The test temperature and humidity shall be the same standard temperature condition Grade 2 and standard humidity condition Grade 2 (temperature 23 ± 2°C and relative humidity 50 ± 5 %) as in 3.1, as a rule.

4. Test Machine and Measuring Instruments

4.1 Test Machine The test machine shall be in accordance with the Appendix Testing Machine for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting.

4.2 Measuring Instrument

4.2.1 Dimension Measuring Instruments The instruments to measure the thickness of film and sheeting, the dimensions of sled and the like which have been specified in JIS B 7503, JIS B 7509, JIS B 7507 and the like, or that which is equal or superior to these in precision.

4.2.2 Stop Watch The stop watch to be used for measuring the slide speed of sled.

4.2.3 Balance The balances to measure the mass of sled and the balance of precision of 20 mg in one graduation specified in JIS B 7601, or that having the precision equal or superior thereto.

5. Test Piece and Other Facing Material

5.1 Shape and Dimensions of Test Piece The shape and dimension of test piece shall be a rectangle of 80 mm in width and 200 mm in length.

5.2 Shape and Dimensions of Other Facing Material The shape and dimensions of the other facing material to be attached to the test table shall be a rectangle of 80 mm in width and of not less than 200 mm in length. In some cases, this other facing material is plastic film (or sheeting) other rigid plastic, metal, rubber or the like.

5.3 Number of Test Pieces and Other Facing Materials The number of test pieces shall be not less than three pieces. The number of the other facing materials shall be not less than three as a rule and when the frictional surface is free from influence upon the subsequent test even by several times of friction, it may be taken as one piece in accordance with the agreement between the parties concerned.

5.4 Manufacture of Test Piece The manufacture of test piece shall be as follows:

(1) Take care that the film and sheeting is directional in according to the method for manufacture and may be different in coefficient of friction according to the existence of surface treatment and to the inside or outside.

(2) For the frictional surface of test piece, cares shall be taken in handling not to be touched by hand and to be free from dirt, dust, foreign matters, etc.

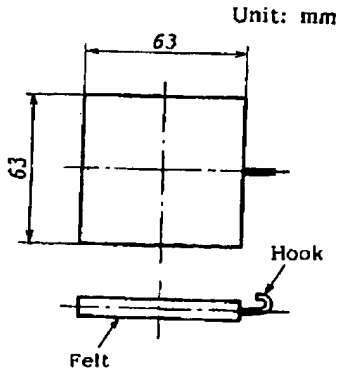
(3) The test piece shall be uniform in thickness and its frictional surface shall be free from fold and creases.

(4) The dirts, dusts, foreign matters and the like, which are regarded that the measurement of coefficient of friction is influenced, shall be removed by a method giving no influence to the measured value.

6. Shape and Dimensions of Sled

The shape and dimensions of sled shall be a regular square of 63 mm in length of one side and the contact surface shall be adhered smoothly with the felt of 2 mm in thickness by R 36 W specified in JIS L 3201. Where it is regarded that the test results is free from influence, due to metallic hooks, the metallic hook of one milimeter in diameter may be attached to the center of the thickness surface of this sled (see Fig. 1).

Fig. 1. Sled



7. Operation

(1) Fix the other facing material with the friction surface upward to the test table so that elongation, bends, creases and the like will not be produced.

(2) Paste one end of the test piece to the auxiliary plate and set it on the other facing material so that elongation, bends, creases and the like will not be produced.

(3) Measure the mass of the sled and confirm that it is 200 ± 2 g.

(4) Set the spring having the spring constant of 2 ± 1 N/cm {200 ± 100 gf/cm} between the load cell and the auxiliary plate when measuring the coefficient of static friction. Connect the load cell with the spring removed and the supporting plate directly when measuring the coefficient of dynamic friction.

(5) Set the sled calmly and in parallel. After 15 sec. have passed, start at a test speed of 100 ± 10 mm/min and begin the test [see Fig. 2 (a) and (b)].

Remark: Where the elongation, bends, creases and the like are produced in the test piece by the use of the sled of 200 g, the test may be carried out with the sled other than that of 200 g. In this case, the used load shall be used for the calculation.

(6) Take the first largest load as the static friction force (F_s) when measuring the coefficient of static friction. Take the average load from the place where the lowest load from the place where the lowest load has been given after passing through the first largest load, to the frictional distance of 70 mm as the dynamic friction force (F_k) (see Fig. 3).

Remark: When testing by using the metallic hook of sled, the similar operation may be carried out by sticking the test piece to the sled to avoid elongation, bends and creases [see Fig. 2 (c) and (d)].

Fig. 2. Example of Coefficient-of-Friction Measuring Machine

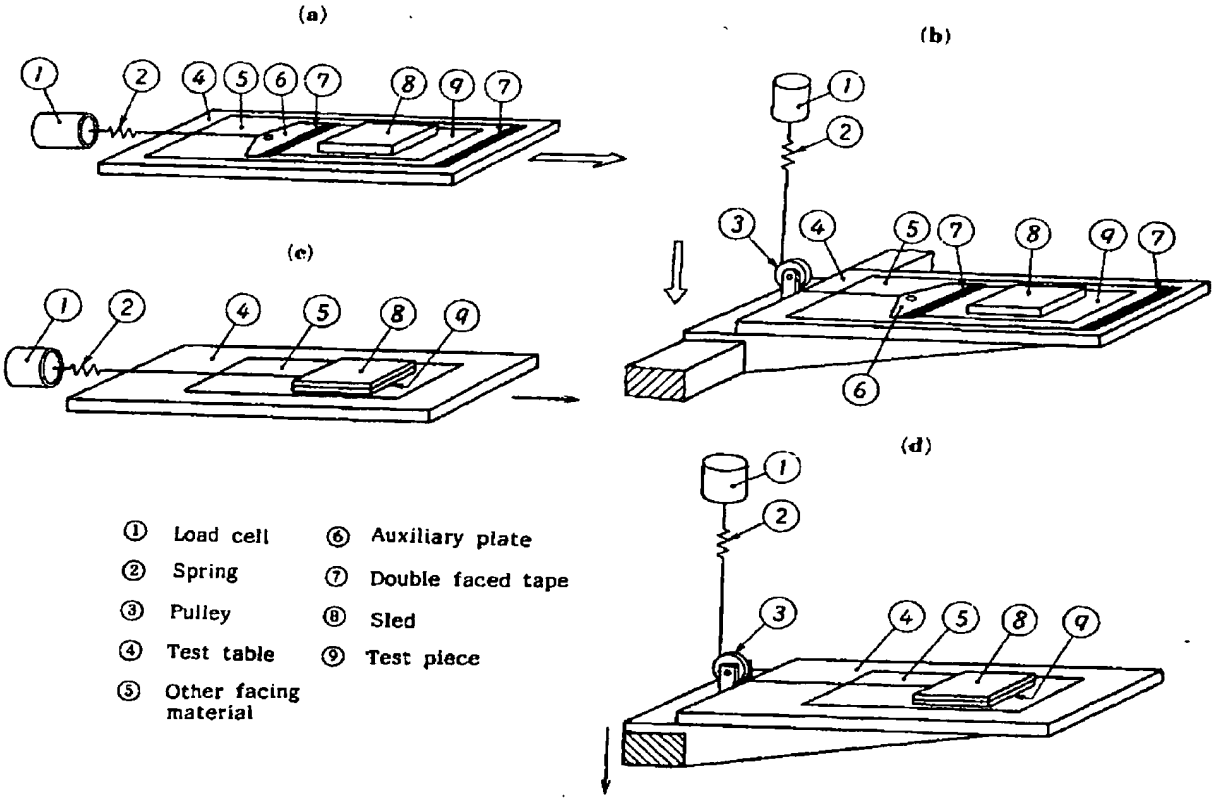
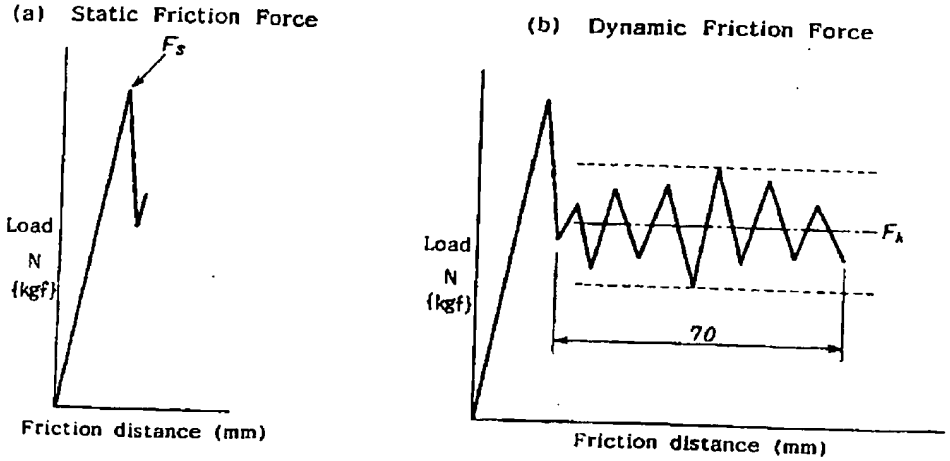


Fig. 3. An Example of Measuring Results of Static Friction Force and Dynamic Friction Force



8. Calculation

8.1 The coefficients of the static friction and the dynamic friction shall be calculated by the following formula (1) and formula (2) respectively.

$$\mu_s = \frac{F_s}{F_p} \quad \cdots\cdots (1)$$

where μ_s : coefficient of static friction

F_s : static friction force N {kgf}

F_p : contact force N {kgf}

$$\mu_k = \frac{F_k}{F_p} \quad \cdots\cdots (2)$$

where μ_k : coefficient of dynamic friction

F_k : dynamic friction force N {kgf}

F_p : contact force N {kgf}

8.2 Calculate the test results individually and round off the average value of their results to a number of two significant figures in accordance with JIS Z 8401.

8.3 When the standard deviation is required, calculate it according to the following formula (3) and round off to a number of two significant figures in accordance with JIS Z 8401.

$$s = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}} \quad \cdots\cdots (3)$$

where s : standard deviation

X_i : each measured value

$\bar{X}$: average value of measured values

n : number of measured values

9. Report

The following items shall be recorded, as required, in the report.

(1) Class of the tested material

(2) Preparing method of test piece (moulding or processing method and its condition)

(3) Temperature, humidity and time of the conditioning of test piece

(4) Form and directional property or both sides of test piece

(5) Number of test pieces and the other facing materials

(6) The other facing materials attached to the test table

(7) Mass of the sled in case where the sled other than the specified load is used.

(8) Test conditions

(9) Temperature and humidity at the test place

(10) Test results

(11) Date of test

(12) Other required matters

Reference: Measuring Method for Coefficient of Friction by Sled of Ring Type

When measuring the coefficient of friction by using the sled of ring type in place of sled (see the text 6.), the method shall be as follows:

1. Test Piece

The form and dimensions of the test piece to be attached to the sled shall be not less than 100 mm in width and not less than 100 mm in length.

2. Form and Dimensions of Sled

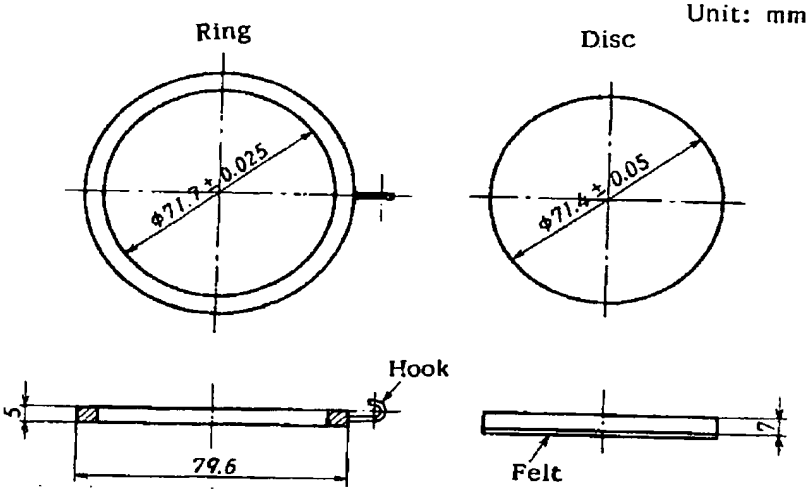
The sled of ring type shall be composed of a ring of 79.6 mm in outside diameter, 71.7 ± 0.025 mm in inside diameter, 5 mm in thickness and a disc of 71.4 ± 0.05 mm in outside diameter and 7 mm in thickness. The contact surface of disc shall have been sticked smoothly with the felt of R 36 W specified in JIS L 3201 and 2 mm in thickness. The sled of ring type shall be equipped with a metal hook of 1 mm in diameter at the nearly center of the thickness surface toward the sliding direction (see Reference Figure).

3. Mass of Sled

The mass of sled of ring type shall be 200 ± 2 g.

Reference Figure. Sled of Ring Type

Unit: mm



Appendix. Testing Machine for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting

1. Scope

This Appendix specifies the testing machine for static and kinetic coefficients of friction of plastic film and sheeting, hereinafter referred to as the "testing machine", which is stated in the body of Standard.

2. Fundamental Performance of Testing Machine

The fundamental performance of testing machine shall be as specified in the Appendix Table.

Appendix Table. Fundamental Performance of Testing Machine

Item		Performance
Relative speed (V) of the sled and the other facing material	mm/min	100 ± 10
Response time of recorder	s	0.5 max.
Indication error of frictional force (F)		± 2 % of indicated value
Surface roughness of test table	μmR_a	0.4 max.
Material of test table		Hard nonmagnetic body
Spring constant for the measurement of coefficients of static friction	N/cm {gf/cm}	2 ± 1 {200 ± 100}

3. Function and Construction of Testing Machine

The testing machine is composed of machine bed and machine frame of the body of apparatus, test table, sled, frictional force detecting part and the like.

Remark: Some testing machines are those equipped the coefficient of friction measuring machine and the tensile testing machine with an apparatus for measuring the coefficient of friction. The testing machines are classified in the type moving the sled and the type moving the test table.

(1) Machine Bed and Machine Frame The machine bed and machine frame shall have sufficient rigidity and the test table shall be smooth in movement and be free from vibration.

(2) Test Table The test table shall be hard non-magnetic materials and the surface roughness of the surface part to which the other facing material is attached, is not more than 0.4 μmR$_a$ in average roughness (R_a) of the center line specified in JIS B 0601 and the run-out of the horizontal plane of the test table of sliding type shall be free from vibration at 100 ± 10 mm per min.

(3) Sled The sled shall be hard in material quality and the felt specified in JIS L 3201 has been adhered to its surface part to contact the test piece. The sled shall be so constructed that the specified load is added sufficiently to the test piece during the movement of the sled. The sliding velocity of the sled shall be 100 ± 10 mm per min. The load, which is vertical to the test table, shall be put on the sled and its mass shall be 200 ± 2 g.

(4) Friction Force Detecting Apparatus The friction force detecting apparatus shall be composed of load cell and recorder and the indicated value shall be ± 2 % in error. Where the recorder is not used, any instrument equal to this in precision, may be used. In order to detect the static friction force, a spring is used between the load cell and the sled.

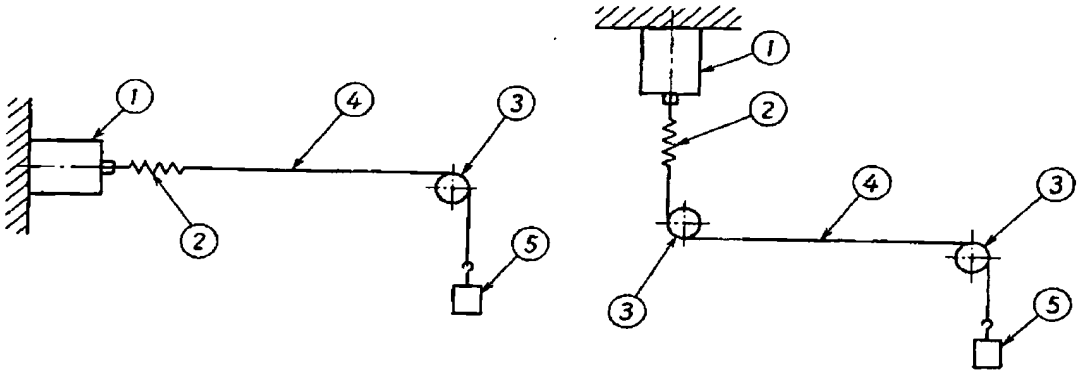
4. Adjustment of Testing Machine

The testing machine shall be inspected in accordance with the following method and meet the specification of 2. In this case, the inspection method equal or superior to this may be used.

(1) Inspection of Moving Velocity of Sled or Test Table Inspect by using a stop watch or a scale that the moving velocity of the sled or the test table is 100 ± 10 mm in moving distance required for 1 min.

(2) Inspection of Friction Force Inspect that the friction force connects the other jigs for inspection, from which the sled has been removed, with the load cell and hang the weight and it is ± 2 % of the indicated value (see Appendix Fig.).

Appendix Figure. An Example of Friction Force Inspection



① Load cell
② Spring
③ Pulley
④ Sled connecting tool
⑤ Weight

(3) Inspection of Sled Measure the mass of sled by a balance and inspect that it is the specified test load.

(4) Inspection of Roughness of Test Table The roughness of the test table shall be inspected by comparing it with the surface roughness standard piece for comparison. The inspection may be carried out by using the roughness inspecting machine having the precision beyond this standard.

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Japanese Text

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